I claim:

1. A method of communication between at least one transmitter and one receiver using carrier-interference multiple-access (CIMA) communication signals, the method comprising the steps of:

    • providing for the generation of a plurality of electromagnetic carrier signals for use by at least one user, the carrier signals having a plurality of frequencies,

    • providing a relative phase to the carriers to produce a predefined phase relationship at a predetermined time,

    • providing modulation of the carrier signals by an information signal,

    • providing for transmission of the modulated, phased carrier signals into a communications channel to produce CIMA transmit signals having carrier-signal components, and

    • providing for reception of the CIMA transmit signals from the channel wherein the carrier-signal components are combined in phase to produce at least one constructive-interference pulse that is indicative of the information signal.

2. The method of communication recited in claim 1 wherein the carrier signals are incrementally spaced in frequency.

3. The method of communication recited in claim 1 wherein the step of providing for the generation of a plurality of electromagnetic carrier signals includes the generation of a plurality of groups of carriers having identical sets of carrier frequencies, each group being assigned to one of a plurality of users, and the step of providing a relative phase to the carriers includes providing a unique relative phase to the carriers of each group wherein each group has a unique time offset in order to generate pulses that are received at different time intervals.

4. The method of communication recited in claim 1 wherein the step of providing for the generation of a plurality of electromagnetic carrier signals includes the generation of a plurality of groups of carriers, each group having a unique set of carrier frequencies and being assigned to at least one user, and the step of providing a relative phase to the carriers includes providing a relative phase to each group such that a plurality of users receives pulses in the same time interval but each user uses different carrier frequencies.

5. The method of communication recited in claim 1 wherein the step of providing for the generation of a plurality of electromagnetic carrier signals having a plurality of frequencies includes the step of providing variations to the carrier frequencies with respect to time wherein the frequency variations for each carrier in a group of carriers corresponding to each user are substantially identical, thereby causing little or no change to the envelope of the pulse.

6. The method of communication recited in claim 1 wherein the step of providing modulation of the carrier signals comprises pulse amplitude modulation being applied to a plurality of the carriers, the

pulse amplitude modulation having a duration that is longer than the pulse width of the constructive-interference pulse.

7. The method of communication recited in claim 1 wherein the step of providing modulation of the carrier signals comprises pulse amplitude modulation being applied to a plurality of the carriers, the

5   pulse amplitude modulation having a duration that is shorter than the period of the constructive-interference pulse.

8. The method of communication recited in claim 1 wherein the step of providing for the generation of a plurality of electromagnetic carrier signals includes tapering the frequency-versus-amplitude window of the carrier signals to reduce time-domain side-lobe energy of the constructive-interference pulse.

10   9. The method of communication recited in claim 1 wherein the step of providing for reception of the CIMA transmit signals includes the step of providing a number of predetermined delays to each received carrier signal before combining to produce the constructive-interference pulse where the number of predetermined delays is equal to the number of different phase spaces in which the received CIMA transmit signal is sampled.

15   10. The method of communication recited in claim 1 wherein the step of providing modulation of the carrier signals by an information signal is performed in a specific time interval relative to the phase of the carriers such that the resulting modulated carriers occupy one or more nonzero-phase spaces and do not combine constructively in zero-phase space to produce a pulse.

11. The method of communication recited in claim 1 wherein the step of providing for reception of the

20   CIMA transmit signals includes compensating for the relative phases of the carriers in at least one of the nonzero-phase spaces in order to combine the carrier signals in phase.

12. The method of communication recited in claim 9 wherein multi-user interference is sampled in the different phase spaces and then weighted and combined with an intended user signal to cancel contributions of the multi-user interference to the intended user signal.

25   13. The method of communication recited in claim 1 wherein the step of providing for the generation of a plurality of electromagnetic carrier signals is performed by a frequency-shifted feedback cavity.

14. The method of communication recited in claim 1 wherein the step of providing for reception of the CIMA transmit signals is performed by a frequency-shifted feedback cavity.

15. The method of communication recited in claim 1 wherein the communications channel is a

30   waveguide.

16. The method of communication recited in claim 15 wherein the electromagnetic carrier signals are optical signals and the waveguide is an optical fiber.

17. The method of communication recited in claim 15 wherein the steps of providing for the generation of a plurality of electromagnetic carrier signals and providing a relative phase to the carriers to

35   produce a predefined phase relationship are performed to match the relative phases between the carriers to the chromatic dispersion profile of the carriers in the waveguide such that the dispersion

14

causes the carrier phases to have a predetermined phase relationship after propagating a predetermined distance in the waveguide.

18. The method of communication recited in claim 1 wherein the step of providing for transmission of the modulated, phased carrier signals includes transmitting the carriers from a transmitter array wherein each carrier for a particular user is transmitted from a separate transmitter element of the array and an array beam pattern is generated from the superposition of transmitted carriers from each of the transmitter elements.

19. The method of communication recited in claim 18 wherein a separation between the transmitter elements is selected with respect to the carrier frequency separation to control the shape of the array beam pattern and the period in which the array beam pattern scans.

20. The method of communication recited in claim 1 wherein the step of providing a relative phase to the carriers results in a train of pulses in the time domain and the step of providing modulation of the carrier signals results in modulating each of the pulses with a direct sequence chip such that the modulated train of pulses is a direct-sequence code.

21. The method of communication recited in claim 20 wherein the direct-sequence chip is the product of an information signal and a chip of a pseudo-random CDMA spreading code.

22. The method of communication recited in claim 1 wherein the step of providing for reception of the CIMA transmit signals includes multi-user detection in which user signals from an intended user and at least one interfering user are received where the interfering user signals are weighted and combined with the intended user's signal to cancel the interfering user signals to the intended user's signals.

23. The method of communication recited in claim 1 wherein the step of providing a relative phase to the carriers to produce a predefined phase relationship at a predetermined time results in at least two received constructive-interference pulses that overlap in time.

24. The method of communication recited in claim 1 wherein the step of providing a relative phase to the carriers to produce a predefined phase relationship at a predetermined time includes a decision step that allows for at least two received constructive-interference pulses to overlap in time when the number of users or channel usage increases beyond a predetermined limit.

25. The method of communication recited in claim 24 wherein the decision step includes a step of identifying the users and assigning a priority to each user that is used to determine which user signals are be selected to overlap in time.

26. The method of communication recited in claim 1 wherein the carrier frequencies for each user are separated by an amount that is equal to or greater than the coherence bandwidth of the communication channel.

27. A carrier-interference multiple-access (CIMA) communication system for providing communication between at least one transmitter and one receiver comprising:

● a CIMA transmitter comprising:

- a multicarrier generator for generating a plurality of electromagnetic carrier signals for use by at least one user where the carrier signals are incrementally separated in frequency,

- a delay controller to cause a predefined phase relationship between the carriers at a predetermined time,

5   - a carrier modulator to modulate the carrier signals with an information signal, and

- an output coupler for coupling the modulated, phased carrier signals into a communications channel to produce CIMA transmit signals having carrier-signal components

• a CIMA receiver for receiving the CIMA transmit signals from the channel, providing a predetermined delay to each of the carrier signal components and combining the carrier-signal

10   components in phase to produce at least one constructive-interference pulse that is indicative of the information signal.

28. The CIMA communication system claimed in Claim 27 wherein the CIMA receiver samples within at least one predetermined time interval to receive at least one pulse in zero-phase space.

29. The CIMA communication system claimed in Claim 27 wherein the CIMA receiver samples a user

15   signal in a plurality of phase spaces at different times and combines the samples in a signal estimator that estimates the information signal.

30. The CIMA communication system claimed in Claim 27 wherein the CIMA receiver is a multi-user detector that samples one or more interfering user signals that interfere with an intended user's signal, weights the sampled interfering signals, and combines the sampled interfering signals with the

20   intended user's signal to cancel multi-user interference.

31. The CIMA communication system claimed in Claim 27 wherein the multicarrier generator is a frequency-shifted feedback cavity.

32. The CIMA communication system claimed in Claim 27 wherein the communications channel is a waveguide.

25   33. The CIMA communication system claimed in Claim 27 wherein the output coupler is an array of transmitters.

34. The CIMA communication system claimed in Claim 33 wherein each element of the array transmits a separate carrier signal for each user, thereby creating a time-dependent beam pattern for each user, and the multicarrier generator controls the frequency separation of the carriers to control the scan rate

30   of each beam pattern.

35. The CIMA communication system claimed in Claim 27 wherein the carrier signals are non-uniformly separated in frequency.

36. The CIMA communication system claimed in Claim 27 wherein one or more functions of at least one of the transmitter and the receiver are performed by digital signal processing.

35   37. The CIMA communication system claimed in Claim 27 wherein the receiver provides gain adjustment to at least one of the carrier signal components to compensate for flat fading.

38. The CIMA communication system claimed in Claim 27 wherein the multicarrier generator provides a tapered amplitude to the carriers to reduce sidelobes.

39. The CIMA communication system claimed in Claim 27 wherein the carrier modulator applies pulse-amplitude modulation to the carrier signals.

5   40. The CIMA communication system claimed in Claim 39 wherein the pulse-amplitude modulation is applied in a predetermined time interval relative to the phases of the carriers to produce one or more CIMA transmit signals that occupy one or more nonzero phase spaces and do not combine constructively in zero-phase space.

41. The CIMA communication system claimed in Claim 40 wherein the communications channel is a

10   waveguide and the frequency separation and the relative phases of the carriers within a pulse-amplitude modulated envelope are selected to match the chromatic dispersion of the waveguide for causing a predetermined phase relationship between the carriers to occur after propagating a predetermined distance in the waveguide.

42. The CIMA communication system claimed in Claim 27 wherein the receiver is a frequency-shifted

15   feedback cavity.

43. The CIMA communication system claimed in Claim 27 wherein the multicarrier generator provides a predetermined amplitude to each carrier signal to generate a train of pulses having a direct-sequence modulation.